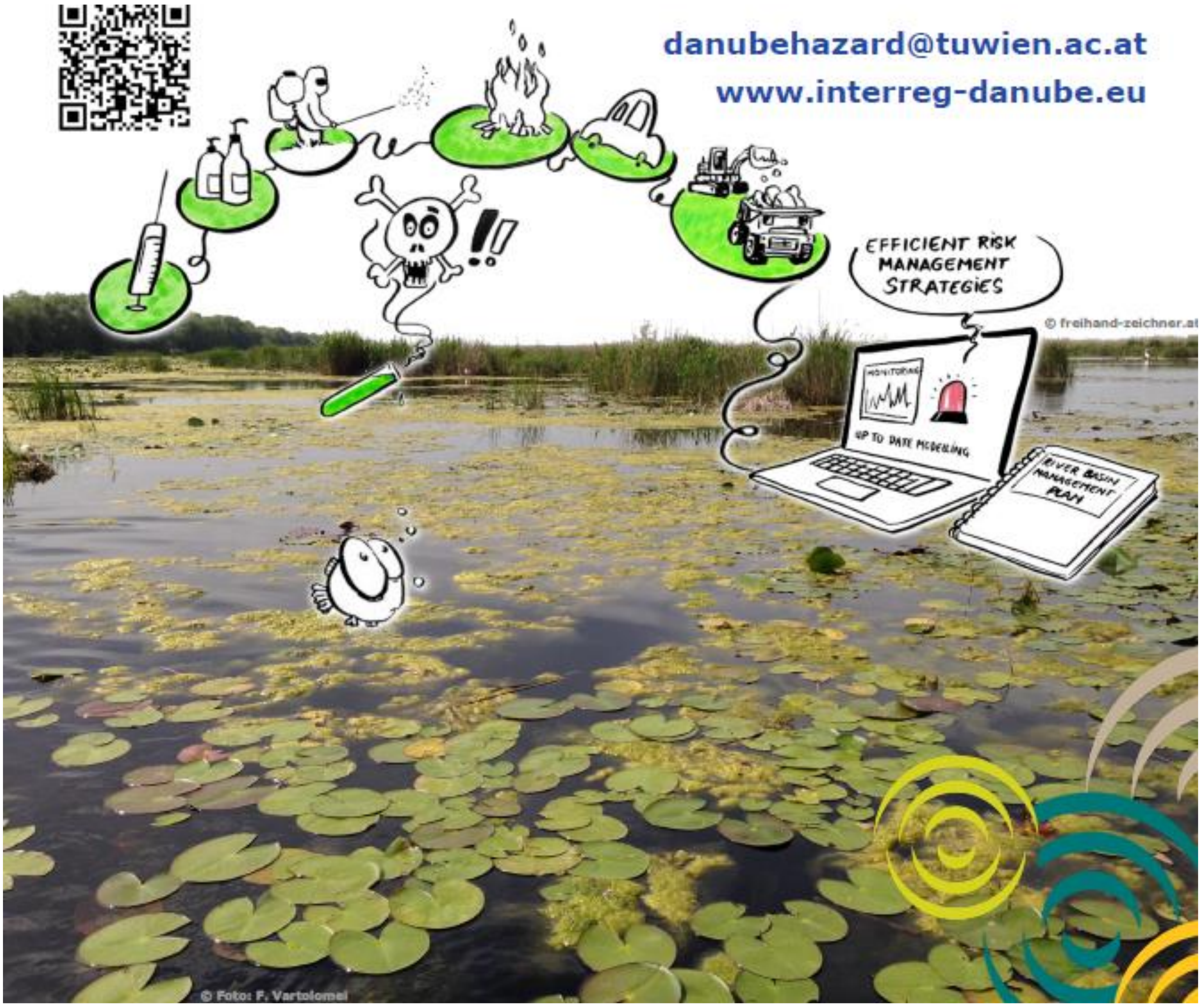
Project Danube Hazard m³c:
Transnational trainings on modelling and scenario evaluation



Output T2.3

Demonstration of the management plan development process at watershed levels for Hazardous Substances pollution based on detailed emission modelling in seven pilot regions 2023

Factsheet for the Zagyva Pilot area

Project co-funded by European Union funds (ERDF, IPA, ENI) and National Funds of the participating countries

PROJECT TITLE: Tackling hazardous substances pollution in the Danube River Basin by Measuring, Modelling-based Management and Capacity building

ACRONYM: Danube Hazard m³c

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1. General introduction

Based on a one-year surface water monitoring, samples were taken once a week and combined to two-months composite samples and analyzed. Sampling took place mostly at low and mean flow conditions. The monitoring was established in all seven pilot regions in four countries (RO, BG, HU, AT) with a total of 20 surface water monitoring sites. From these results a mean annual concentration was calculated, which should be comparable to 12 fold monthly monitoring results, often used for the risk assessment under the Water Framework Directive. The risk assessment considers the following different inorganic and organic substances:

- Perfluorooctanesulfonic acid (PFOS), Perfluorooctanoic acid (PFOA) (industrial chemicals)
- 16 EPA Polycyclic aromatic hydrocarbons (PAHs, industrial chemicals, and combustion by-products)
- Mercury (Hg), Cadmium (Cd), Copper (Cu), Nickel (Ni), Lead (Pb), Zinc (Zn), Chromium (Cr) and Arsenic (As) (metals)
- Diclofenac and Carbamazepine (pharmaceuticals)
- 4-tert-Octylphenol (industrial chemical)
- Nonylphenol (industrial chemical)
- Bisphenol A (industrial chemical)
- S-Metolachlor (herbicide) including Metolachlor-ESA and Metolachlor-OA (metabolites)
- Tebuconazole (fungicide)

Results from all monitoring stations were compared with the environmental quality standards (EQS) of Directive2008/105/EU (Priority Substances) and with the substances enacted at the national level (National Substance List). Exceedances are shown in **Fehler! Verweisquelle konnte nicht gefunden werden.**.

Table 1 Overview of the exceedance of the EQS in all pilot areas. The numbers indicate the number of sites, regions and countries with exceedance of the EQS values

Substance > EQS	Substance Group	No of monitoring sites	No of pilot regions	No of countries	Regulation
PFOS	Industry	9	5	4	Directive 2008/105/EU
Cu	Heavy Metals	2	1	1	National Substance List
Cd	Heavy Metals	2	1	1	Directive 2008/105/EU
Zn	Heavy Metals	2	1	1	National Substance List
s-Metolachlor	Pesticides	2	1	1	National Substance List

In a second step, for each substance, dominant pathways were evaluated for each catchment by means of emission modelling. Considering the dominant polluters or pathways, scenarios were formulated, which, describe the general potential of a specific measure to mitigate pollution.

The emission modelling was carried out for 34 sub-catchments in seven pilot areas which are situated in four countries. A detailed description of the model, the modelling results and validation can be found in OT 2.2 Report on improved system understanding.

Note: The new proposals of the revised Priority Substance List were also assessed, but do not form a legal basis for the designation of measures at the present time.

2. General information Zagyva Catchment

The Zagyva catchment is devided into five sub-catchments. At four sub-catchment outlets monitoring stations are available.

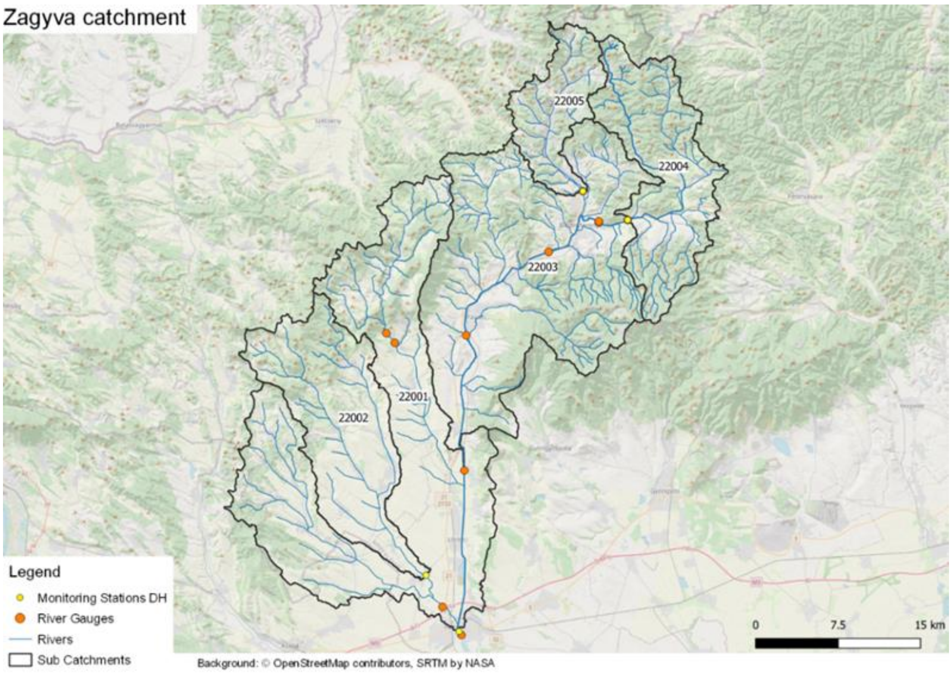

Figure 1 Overview of the pilot area, with monitoring stations

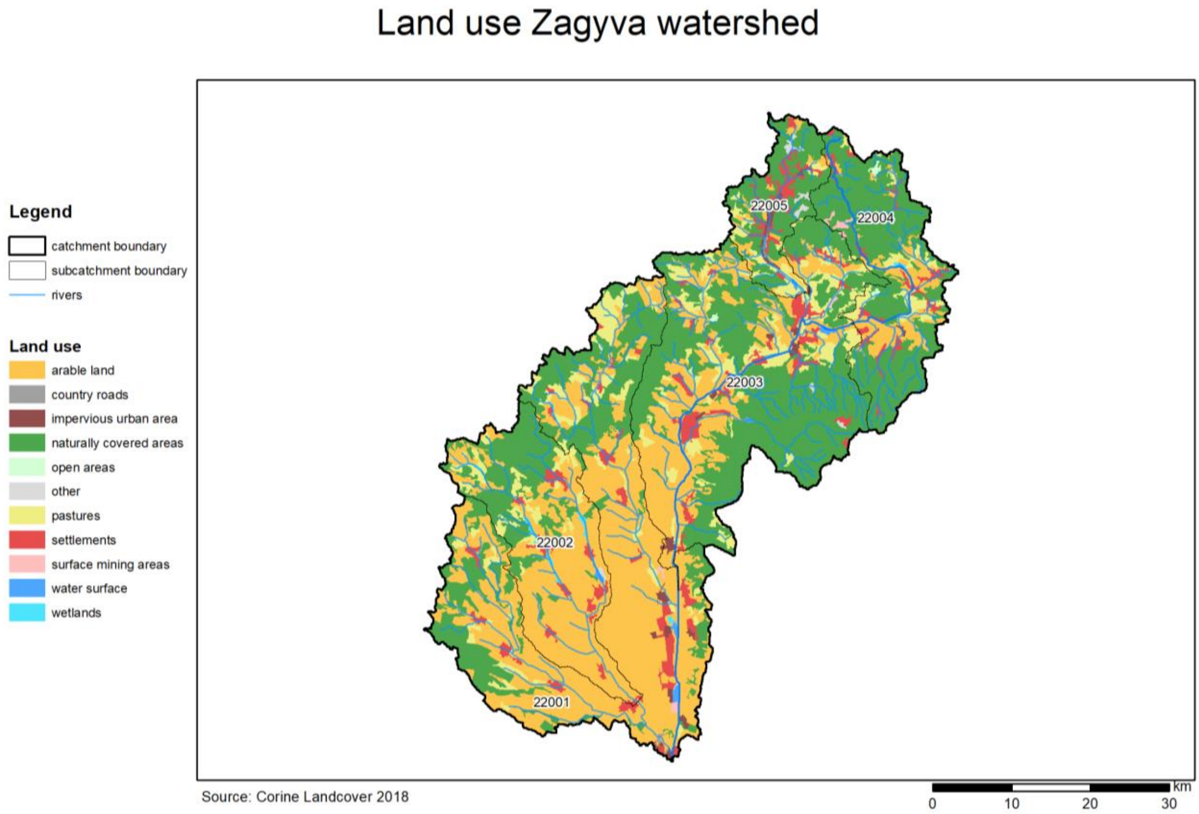

Figure 2 Land use in the pilot area

Forests dominate the landuse of Zagyva especially in the upstream catchments in the north, but even in the western parts of the catchment. The arable land, which also has high shares on landuse are situated in the southern parts in sub-catchment 22002 and 22001. The population density is moderate to high (also expressed in moderate to high values of urban area). Wastewater Treatment Plants are operated in each sub-catchment. The runoff is the lowest in all pilot regions.

Table 2 Basic information for the Somesul Mic pilot area

Pilot region	Catchment Area [km2]	Mean Elevation [m]	Population density [Inh/km2]	Arable land [%]	Arable land > 4% slope [%]	Pasture [%]	Forest [%]	Urban Area [%]	Runoff [mm]
Zagyva	1200,2	266,3	95	30,5	15,4	11,0	45,8	5,4	40

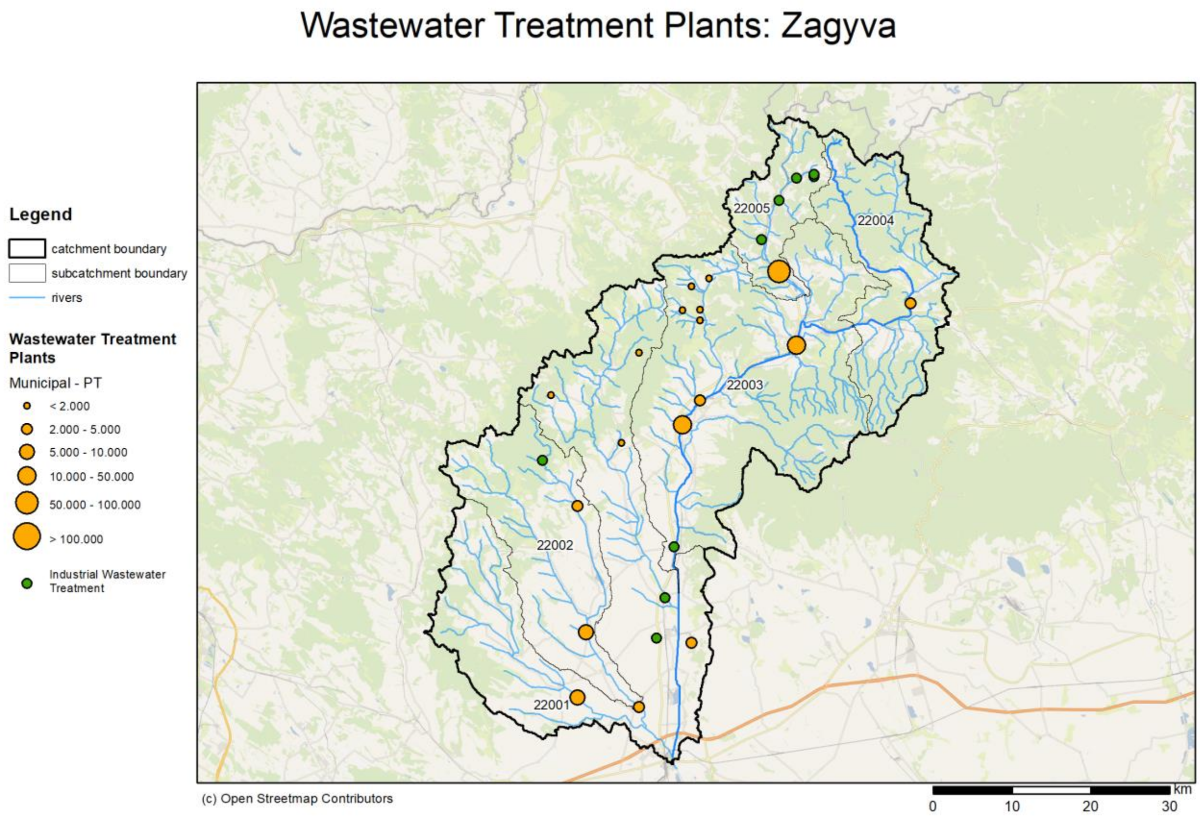

Figure 3 Overview of the point sources in the pilot area

In Zagyva chatchment 8 small municipal WWTPs with a capacity below 2000 PE, 10 municipal WWTPs with a capacity above 2000 PE and 9 industrial WWTPs are present.

3. Risk assessment: Industry and wastewater/Perfluorooctane sulfonic acid (PFOS)

Exceedance of the PFOS EQS (0,00065 µg/l) were measured in three of four monitored catchments. In 22005 there is a measured exceedance by factor 2,2; factor 1,4 in catchment 22004 and 2,0 in catchment 22002. At the outlet of the modelled region (22001), PFOS EQS are undershoot by factor 0,94. Model results give evidence that in sub-catchment 22003 (no monitoring) PFOS concentration will be slightly above the EQS.

General information: Perfluorooctane sulfonic acid (PFOS) (CAS number 1763-23-1) belongs to the substance group of per- and polyfluorinated alkyl compounds. Due to the surface-active properties of PFOS and related compounds, they are also referred to as perfluorinated surfactants (PFTs). PFOS were formerly used in a wide variety of applications such as fire extinguishing foams, photo resist paints, photographic coatings, medical devices, insecticides, textiles and carpets, and paper and packaging. Due to persistence and surface-active properties, once contaminants such as PFOS enter wastewater, they are very difficult to remove. The main pathways of PFOS to enter in surface waters are wastewater effluents (industrial and municipal wastewater), surface runoff and groundwater.

3.1 Specific situation for Zagyva

In the investigated region, model results underestimate the PFOS concentration in 22004 and 22002. Emissions from separate sewer systems overflows have a significant share of the total PFOS emission in the Zagyva pilot region. Further significant shares of total PFOS emission are calculated from groundwater, which resulting from a high proportion of the water balance at low concentrations. In the Zagyva pilot region almost in all sub-catchment, municipal WWTPs and even industrial direct dischargers are present. However, their total share on the PFOS emission in the catchments is only around 15%. Only in one of the upstream catchments (22005), the share of municipal and industrial wastewater is in a magnitude of more than 40% with a clear dominance of the municipal wastewater, having a significant share on the net discharge in this catchment.
While Information from the Swedish EPA (2017) point out, that the purification capacity of PFOS can be increased to 75 % by using activated carbon, a reduction of PFOS emission from storm-water discharges from separate systems is not easy to achieve. Scenario results from an earlier study (STOBIMO Spurenstoffe, 2019, https://info.bml.gv.at/themen/wasser/wasserqualitaet/fluesse_seen/stobimo-spurenstoffe.html), increasing the solids retention before discharge in storm water overflow and combined sewer overflow, point out only a slight reduction for PFOS (as a consequence of its system behavior).

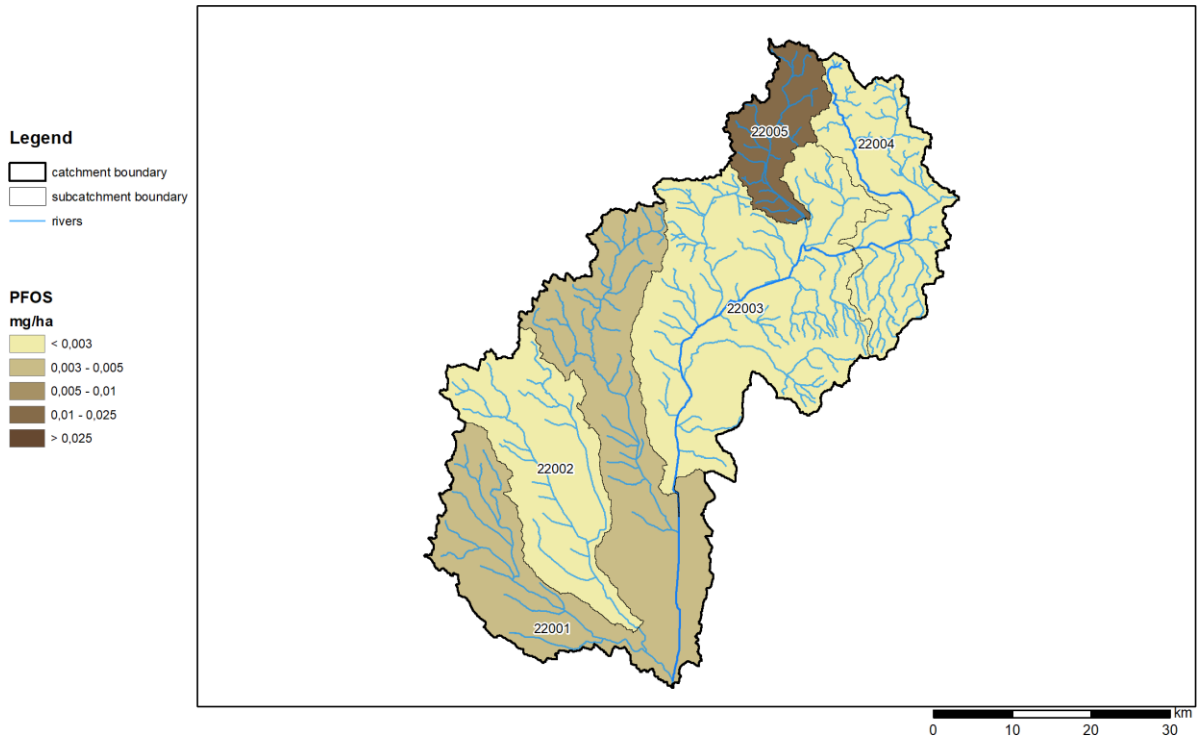

Figure 4 Area specific total PFOS emissions in the Zagyva catchment.

When looking at the relative share of pathways in figure 5, is can be seen that the WWTP in 22005 has a large relative share, where the relative share of the WWTPs in the other sub catchments is significantly smaller. The relative share of the emissions from roads outside of settlements is around 20%, which can be explained by the use of the CORINE landcover data, where the area of roads outside of settlements is overestimated.

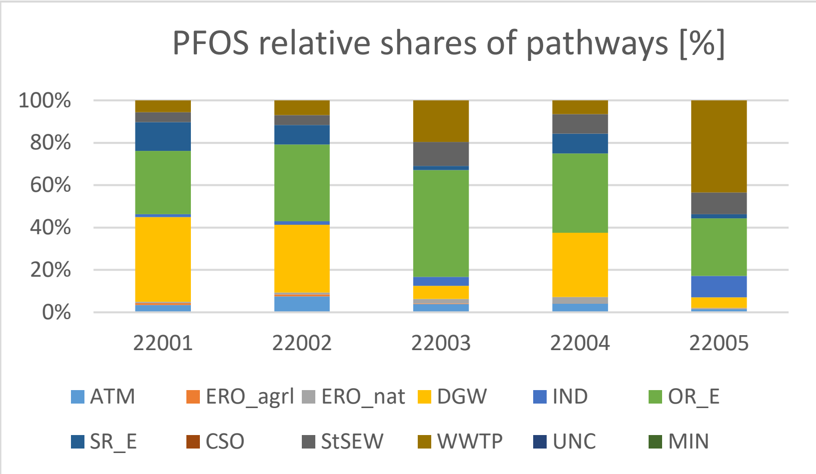

Figure 5 Relative share of pathways for PFOS in all Zagyva subcatchments.

3.2 Proposals for potential mitigation measures:

Advanced wastewater treatment at the municipal wastewater treatment plants (> 10.000 p.e.). Adsorption stage (activated carbon) for municipal wastewater treatment plants. The measure could be implemented in three municipal wastewater treatment plants (Salgótarján, Pásztó, Bátonyterenye) in the catchment area. The proposed measure is based on proposals from the revised Urban Waste Water Treatment Directive, which discusses construction of a 4th purification stage for municipal wastewater for settlement areas > 10.000 – 100.000 p.e. (2040) in case of a risk.

Tighten regulations on industrial emissions, and introduction of emission limit values. PFOS emissions can also be linked to industrial activity (primary sources are metal processing and metallurgy, but the processing industry is also a potential source). Based on the relevant legislation, effluent control only covers the substances specified in the operating license. Existing permits should be revised with the expansion of the range of parameters included in self-monitoring. Stricter self-monitoring of direct industrial emitters and industrial plants discharging the public sewer would be required.

Mitigate emissions from historical urban and industrial sources. The proposed measures are contaminated area remediation (excavation, monitoring, insurance, liquidation) in abandoned and operating areas, appropriate design, operation and control of municipal landfills.

Please note: The proposed measures are based exclusively on what is theoretically feasible and quantifiable as a scenario in the model. They do not consider the aspect of proportionality and have no impact on a possible practical implementation!

3.3 Results from the modeled scenarios

In the emission model only the measure **Advanced wastewater treatment at the municipal wastewater treatment plants (> 10.000 p.e.)** was implemented.

If the PFOS concentration of municipal WWTPs with a capacity above 10.000 is reduced by 75%, due to the implementation of advanced treatment with activated carbon, the river concentration of PFOS will reduce by 0% in the sub catchments without WWTPs with a capacity above 10.000 PE to 40% in 22005, please see table 3 for detailed information.

Table 3 Reduction of PFOS river concentration in percentage.

ID of analytical unit	Reduction of river concentration in %
22001	12
22002	0
22003	28
22004	0
22005	41

3.4 Initiate a stakeholder involvement

In the scope of this project a questionnaire was set up to gain information on the feasibility of mitigation measures concerning the reduction of PFOS concentrations in the Zagyva catchment. local, regional and national experts participated in the questionnaire. All experts agreed that an upgrade for WWTPs with a capacity above 10.000 PE is technical feasible. 40% thinks that 10 years is a realistic time line for the expension, whereas 60 % believes that this will take longer than 15 years. All participants agree that tightening regulations on direct industrial emitters and industrial plants discharging the public sewer is necessary to reduce emissions. 60% of the experts think a reduction of PFOS can be established by other/further mitigation measures such as: Substitution of PFOS by other substances, Significant improvement of selective waste collection, Restoring natural vegetation in the riparian zones of streams and watercourses.

4. Closing the data gaps

As can be seen from the pathway analysis in paragraph 3.1, the relative share of emissions from roads outside of settlements are very large, due to the overestimation of the area of roads outside of settlements. For further studies in the field of emissions modelling, the used landcover data should be analysed in this respect.

5. Literature

Swedish EPA (2017). Advanced wastewater treatment for separation and removal of pharmaceutical residues and other hazardous substances: Needs, technologies and impacts. Swedish Environmental Protection Agency. Report 6803, April 2017, Stockholm, Schweden. https://www.naturvardsverket.se/Documents/publikationer6400/978-91-620-6803-5.pdf?pid=21820

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